METHOD AND APPARATUS FOR ADJUSTING MULTIPLE PROJECTED RASTER IMAGES

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application claims the benefit of U.S. Provisional Patent Application entitled METHOD OF USING REGISTERED MEMORY ARRAYS TO MATCH COLORS BETWEEN MULTIPLE PROJECTORS, Ser. No. 60/032,375, filed Dec. 10, 1996; U.S. Provisional Patent Application entitled FULL RASTER ADJUSTABLE MULTIPLE IMAGE SMOOTHING METHOD, Ser. No. 60/032,376, filed Dec. 10, 1996, and U.S. Provisional Patent Application entitled METHOD OF AUTOMATICALLY DEFINING THE EDGE OF A RASTER IMAGE FOR MAPPING TO A MEMORY ARRAY, Ser. No. 60/032,489, filed Dec. 10, 1996.

BACKGROUND OF THE INVENTION

This invention relates generally to displaying multiple raster images, and more specifically to a system for adjusting raster images to compensate for projection defects when multiple raster images are displayed together to form a single composite image.

Groups of video projectors can be arrayed into electronic displays that offer larger, brighter, and higher resolution images. A video projector array provides additional benefits such as increased image size without loss of image brightness, increased image resolution, increased depth of focus, and a reduced projection distance. Although matrixed walls of individual video displays are the most common example of electronic image arrays, the limiting factor of traditional video walls is the visual segmentation between the displays. Minimizing the segregation between arrayed images is highly desirable. The goal is to make video arrays wherein the segregation is indistinguishable.

Overlapping and seamlessly blending multiple video projectors into a single composite image goes a long way towards eliminating the segregation of projector elements and opens the way to many new practical applications. This technique is particularly applicable to the display of computer graphics material. Computers have the ability to generate multi-channel composite images at resolutions far exceeding traditional electronic media and even the maximum resolution of any single monitor or projector. These large images can only be displayed using an arrayed system.

The challenge is to make the entire projection array behave as a single image display device. An array can be managed with integrating electronics to create a "virtual" package around multiple projectors, arrayed in adjacent and registered geometries, with the entire package behaving as a single cohesive imaging device.

Existing array formats include edge matched, edge blended, wide field, and matrixed. Edge matched formats rely on clean projection geometries where two projected images are immediately adjacent to one another. Defining a perfect single pixel row edge between projectors is improbable because small variations in the vertical geometry cause small overlaps and brightness aberrations between the images. It is typically better to have a definitive mechanical edge to the image, and it is preferable that there is an actual black separation between the array elements in such applications. The separation serves to mask small misalignments and to provide visual relief between slightly imperfectly tuned edge-matched display components.

Edge blended formats rely on an overlap region with redundant picture information from each projector in the overlap. The overlap region is, therefore, double the brightness of the rest of the image and needs to be blended using an edge blending processor capable of fading down each overlapping edge of the projectors in such a way as to compensate for the gamma (the ratio of input voltage to light output) of the phosphor, light valve or LCD. The goal is a uniform brightness level across the overlap region.

Wide field arrays are an extension of the edge blended format. Wide field arrays use adjacent geometries. The displays are laid out in horizontal patterns to create wide scope images. Alternatively, the projectors may be stacked vertically to create very tall images.

Matrixed arrays organize projectors in XY grids (i.e., they contain multiple displays in the horizontal and vertical directions). Video walls are an example of a matrixed array. The unique challenge in this geometry format is the need for separate soft edge blend control in the corner regions where all four projectors overlap.

The actual projector arrays can consist of any projector scheme, including CRT, light valve, DMD, laser or LCD projectors. Using CRT projectors provides the most flexibility in terms of geometry control but limits each projector array element to the maximum size and brightness of the individual CRT projector. Using bright light valve projectors allows for the expansion of the overall size of the array, and since several light valve imaging schemes are driven by scanning CRTs, these models still allow for good geometry control of the image. LCD projectors have the potential of offering a low maintenance and low cost solution for arrayed projection. LCD projectors, however, have virtually no geometric controls. Since they tend to be single lens devices, this limitation may be overcome in pre-integrated arrayed systems where fixed custom optics can be applied.

Arrayed projection displays typically exhibit various artifacts or defects that are noticeable to the human observer. Such effects as improper projector shading, optical vignetting (also known as "hot spots"), and horizontal color shifting negatively affect the composite image. As arrayed projection displays get larger and include more independent raster images, new techniques are needed to ensure that the composite projected image is of the best quality.

SUMMARY OF THE INVENTION

The present invention is embodied in a new soft edge blending processor and associated software that are capable of affecting all four sides of a projected composite image, thereby enabling the construction of arbitrarily large, seamless projections of raster images. The invention corrects many artifacts in an arrayed projection system that may be perceived by a human observer.

An embodiment of the present invention is a system for adjusting video signals representing an array of raster images to compensate for projection defects when the array of raster images is displayed by a plurality of projectors to form a composite projected image. The system includes a three dimensional array of smoothing factors, each smoothing factor being associated with a portion of the composite projected image; and circuitry for applying the smoothing factors to the video signals to remove the projection defects resulting from display of the array of raster images.

Another embodiment of the present invention is a method of matching arrayed projectors to produce a composite raster image projected by the projectors on a projection screen and having consistent red, green, and blue color values. The